

CLAIMS

What is claimed is:

1. An N×N circular expander for serving a connection request to route k incoming  
 5 signals,  $k \leq N$ , and for enabling conditionally nonblocking switching, the circular expander comprising

- a switch defined by a set of connection states and having an array of N  
 input ports with N distinct input addresses and an array of N output ports with N distinct  
 output addresses wherein the k incoming signals arrive at k distinct input ports determining  
 10 k active input addresses and are destined for corresponding k distinct output ports  
 determining k active output addresses, the switch accommodating every combination of  
 concurrent connections, point-to-point or multicast, subject to the following constraint: if  
 the input ports i and j are connected to the output ports p and q, respectively, then  $\|i-j\|_N \leq$   
 $|p-q|$ , where  $\|i-j\|_N = \min \{|i-j|, N-|i-j|\}$  is the distance between i and j on the discretized  
 15 circle size N, and

control circuitry, coupled to the switch, for routing the incoming signals  
 from the k distinct input ports to the corresponding k distinct output ports by activating one  
 of the connection states such that the activated one of the connection states accommodates

the connection request.

2. The circular expander as recited in claim 1 wherein  $N=2$  and the switch is a switching cell.

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3. The circular expander as recited in claim 1 wherein the switch is constructed by an  $N \times N$   $k$ -stage switching network composed of  $k$  stages of nodes, an interstage exchange between any succeeding two of the  $k$  stages, an input exchange and an output exchange, and wherein each node is filled with another switch.

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4. The circular expander as recited in claim 1 wherein the switch is constructed by an  $N \times N$   $k$ -stage switching network composed of  $k$  stages of nodes, an interstage exchange between any succeeding two of the  $k$  stages, an input exchange and an output exchange, and wherein each node is filled with another circular expander.

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5. The circular expander as recited in claim 1 wherein  $k=2$  and the switch is constructed from a two-stage interconnection network composed of a first stage of nodes being the input nodes and a second stage of output nodes being the output nodes, an

interstage exchange, and an input exchange corresponding to the interstage exchange prepended to the network, and wherein each node is filled with another circular expander.

6. The circular expander as recited in claim 1 wherein the switch is  
5 constructed from a 2X interconnection network having nodes and wherein each node is filled with another circular expander.

7. The circular expander as recited in claim 1 wherein the switch is  
constructed from a 2X interconnection network having nodes and wherein the nodes are  
10 filled with a plurality of other circular expanders.

8. The circular expander as recited in claim 1 wherein the switch is  
constructed from a recursive 2X interconnection network having nodes and wherein each  
node is filled with another circular expander.

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9. The circular expander as recited in claim 1 wherein the switch is  
constructed from a recursive 2X interconnection network having nodes and wherein the  
nodes are filled with a plurality of other circular expanders.

10. The circular expander as recited in claim 1 wherein the switch is constructed from a divide-and-conquer network prepended with a SWAP exchange.

5 11. The circular expander as recited in claim 1 wherein the switch is constructed from a recursive 2X interconnection network having nodes and wherein each of the nodes is a cell and each cell is filled with a 2×2 circular expander.

10 12. The circular expander as recited in claim 11 wherein the 2×2 circular expander is a switching cell.

13. The circular expander as recited in claim 1 wherein the switch is constructed from a recursive 2X interconnection network of cells with each cell filled with a 2×2 circular expander.

15 14. The circular expander as recited in claim 13 wherein the 2×2 circular expander is a switching cell.

15. The circular expander as recited in claim 1 wherein the switch is constructed from a banyan-type network whose trace and guide are both monotonically increasing and wherein each of the  $2 \times 2$  nodes of the banyan-type network is filled with a  $2 \times 2$  circular expander.

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16. The circular expander as recited in claims from 15 wherein the  $2 \times 2$  circular expander is a switching cell.

17. The circular expander as recited in claim 1 wherein the switch is constructed from a recursive 2-stage interconnection network of cells prepended with a SWAP exchange and wherein each cell of the network is a  $2 \times 2$  circular expander.

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18. The circular expander as recited in claim 17 wherein the  $2 \times 2$  circular expander is a switching cell.

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19. A method for constructing an  $N \times N$  circular expander to serve a connection request to route  $k$  incoming signals,  $k \leq N$ , the method comprising configuring a switch defined by a set of connection states and having an

array of N input ports with N distinct input addresses and an array of N output ports with N distinct output addresses wherein the k incoming signals arrive at k distinct input ports determining k active input addresses and are destined for corresponding k distinct output ports determining k active output addresses, the switch accommodating every combination of concurrent connections, point-to-point or multicast, subject to the following constraint: if the input ports i and j are connected to the output ports p and q, respectively, then  $\|i-j\|_N \leq \|p-q\|$ , where  $\|i-j\|_N = \min \{|i-j|, N-|i-j|\}$  is the distance between i and j on the discretized circle size N, and

- routing the incoming signals from the k distinct input ports to the corresponding k distinct output ports by activating one of the connection states such that the activated one of the connection states accommodates the connection request.

20. The method as recited in claim 19 further including, prior to routing, activating one of the connection states in response to the connection request.

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21. The method as recited in claim 19 further including, prior to activating, selecting one of the connection states in response to the connection request.